Report from a French incident

Contamination of students with Americium-241 due to poor procedures

Description of incident

A practical work instructor and three students ("A", "B" and "C") performed an experiment aimed at revealing the damage caused by alpha particles in cellulose nitrate films. During this, two students contaminated their hands with americium-241.

The source was 1,4 MBq (39 µCi) of Am-241 deposited by electrolysis on a platinum plate. The target used was a cellulose nitrate film. The students had to vary the irradiation time and the distance in relation to the source and study the traces formed by the alpha particles in the detector. The sequence of events was as follows:

- In the morning, the radioactive source was placed by the one of the students, "A", on the support using pliers, under the control of the teacher responsible for practical work. Four films had been irradiated in the morning.
- The students then went for their meals during the film development period; no contamination check had been carried out at the end of the morning.
- In the afternoon, not able to fine-tune the microscopes, the students call upon the teacher; he then contaminates the pliers by grasping the radioactive source to verify its positioning on the assembly. A contamination check is carried out and the following are detected:
  - Contamination of the fingers of Mr. "A" and Mr. "B"; the third student has not been contaminated.
  - Localized contamination of the pallet, a plastic ruler, the tripod and support of the radioactive source.
  - Contamination of one of the films.
- The students wash their hands with soap and water; there is still radioactive contamination of Mr. A's hands, treated using latex gloves (about one hour), then washing with a special solution. Given the persistence of the contamination, an application of DTPA in aqueous solution on compresses is started. After the second application, Mr. A's hands are still contaminated; the student is wearing latex gloves until the next day; after washing, there is no trace of radioactive contamination left.
- A faecal sample is requested the day after the contamination. It reveals an activity of 0.25 Bq for Mr. A and 0.0045 Bq for Mr. B. A further analysis of faeces and urine is requested on the 60th day following the contamination. It is negative for Mr. A and Mr. B.

The origin of the contamination was then found. One of the films fell onto the radioactive source through the support slots during the irradiation. One of the students, Mr. "A", was contaminated by "recovering" the film without taking precautions and without indicating the incident to the instructor of practical work. This contamination, having occurred in the morning, was only discovered that afternoon during verifications carried out in the wake of the contamination of the pliers. The internal contamination was most likely caused by ingestion during the meal.

Radiological consequences

Given the contamination levels measured for Mr. A (0.25 Bq) and Mr. B (0.0045 Bq) as a result of the faeces analysis, the following doses have been estimated:

1) Mr. "A"

- We know that the fecal excretion the day after exposure represents 11% of total activity inhaled and 28% of total activity ingested (ICRP 72 and 78).
- The dose received by Mr. A is estimated at 0.2 µSv assuming that Mr. A had inhaled all the activity (the dose coefficient commitment to the whole body for the americium 241 being 9.6. 10^{-5} Sv/Bq inhaled).
- If we assumed that Mr. A ingested all the activity, the dose that he received is estimated at 0.1 µSv (the dose coefficient being 2.10^{-7} Sv/Bq ingested).

2) For Mr. "B"

- Using the same reasoning, it can be estimated that the dose received by Mr. B is 4 nSv, assuming that it he inhaled all the activity, and 2 nSv assuming that he ingested all the activity.

These doses are low, they represent less than 1/10000th of the annual dose limit for the public (1 mSv). However, they reflect a lack of understanding of the elementary rules of radiation protection by the students. The contamination was detected only by accident. The same behavior could have led to significantly higher exposures during other operations.

Lessons to be learned from the incident

Students must be trained at the beginning of the year on radiological risks and the ways to minimize them. Students should know the qualified persons in charge of radiation protection (name, and contact details.) to advise them in the event of an incident. Any anomaly in the conduct of the practical work session should be reported.

For each practical work session:

- Special restrictions should be displayed at workstations (handling guidelines, radiological control before leaving the practical work room, washing hands after handling, protocol to follow in case of contamination, etc.).
- Gloves must be made available and must be worn for the duration of the operation. Students should change gloves before moving on to something else.
- Students must wear a laboratory coat and protective eyewear in order to avoid any contamination of clothing and in eyes.
- The teacher must be present throughout the practical work sessions involving ionizing radiation.

In the case of contamination, if it persists after washing hands with a decontamination product, wearing gloves will keep the individual from spreading the contamination and keep it from turning into internal contamination by ingestion (when eating, for example).

According to raddionuclides used during experiments, suitable monitoring and decontamination equipments and procedures must be in place before the work starts.